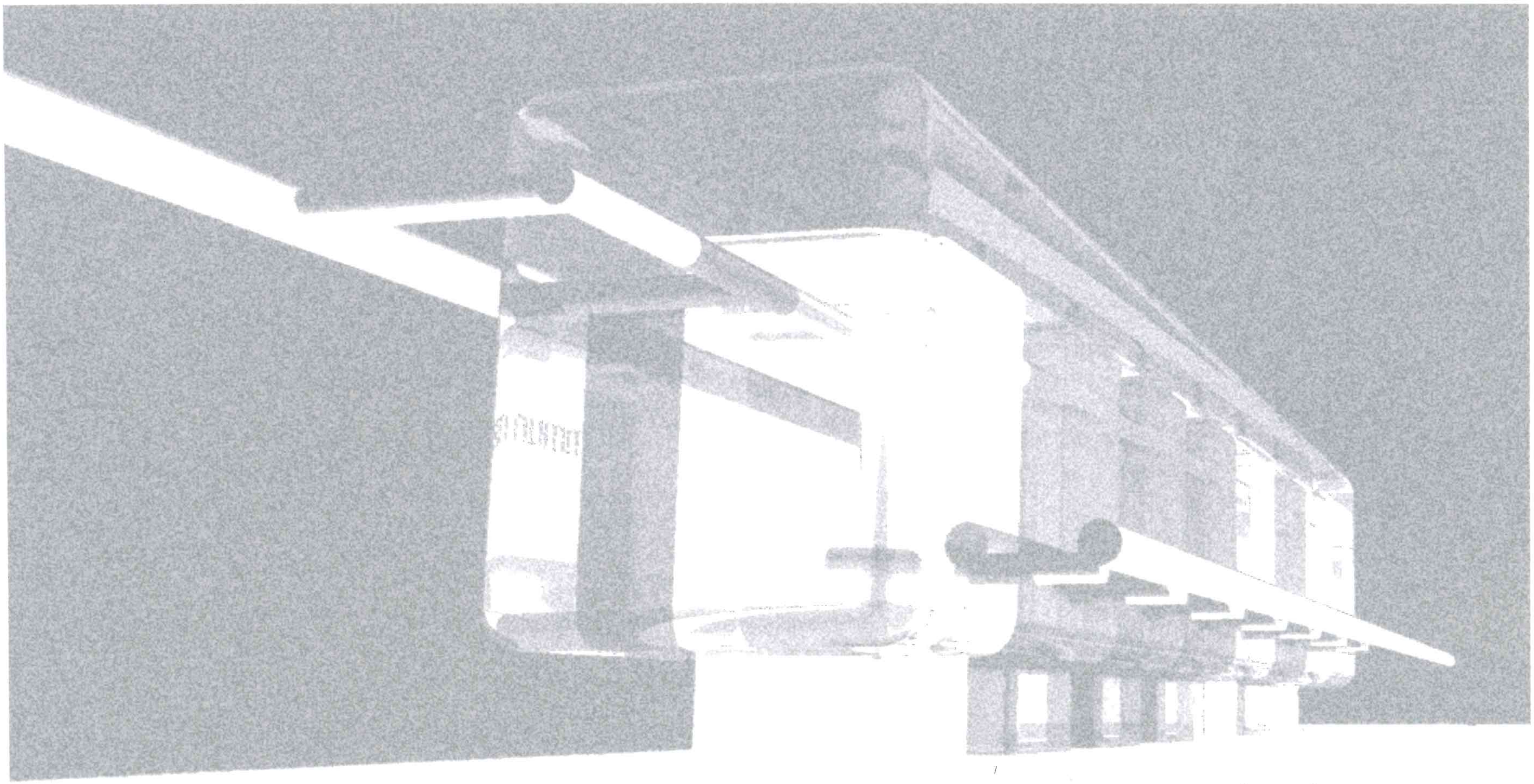

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The Urban Systems ProtoType

Final Thesis Submission

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1.0 Thesis Statement

Historically, new typologies emerge when there is a strong social agenda. When this is combined with advances or changes in technology, significant changes occur in architecture that mirror those of society. We are currently witnessing both of these phenomena. In this case, a strong environmental agenda now pervades every major social institution, while new building technologies and materials are evolving from an extensive study of nature's systems. A shift in our technological model is the thread that connects these two significant cultural facts.

2.0 Introduction

We have relegated nature to the status of 'resource', a term alien to nature's system. One of the ways we represent our relationship with nature is through technology. We use technology to build structures that compensate for our biological makeup, which is designed for the African Savanna. *'Human exploration of new territories / climatic zones made necessary the technological development of forms to provide for human survival and comfort.'* [1] We have evolved technology in lieu of our skin; this has enabled us to adapt to different climates quickly, and therefore expand our habitat to encompass the globe. Our dwellings, as extensions of our skin, were designed for specific climates. As our technology developed, our expectations of comfort increased, culminating in the hermetically sealed glass box, the ultimate in artificiality. *'Our senses were developed for outdoor life, the setup of our senses has not changed. There is no better light than daylight, no better air than fresh air.'* [2] We have a parasitic relationship with nature, a one way relationship of exploitation. This, in and of itself, is not as negative as it sounds, because parasites are part of the natural order. In nature, however, parasites do not normally kill their hosts because they are their source of food. Man, on the other hand, will exploit a resource until it has been depleted. The accepted doctrine of human superiority makes this acceptable. *'In reality we have not escaped the gravity of life at all. We are still beholden to ecological laws, the same as any other life-form. The most irrevocable of these laws says that a species cannot occupy a niche that appropriates all resources, there has to be some sharing.'* [3]

3.0 Social Agenda in Relation to Technology

3.1 History of Environmental Movement

Many pre-Christian and Islamic religions believed that all objects had a spiritual being, call animism. This belief fostered a sense of respect and protection for the environment, mostly out of fear. In the early part of the 18th century, the intellectual revolution, that began in the Renaissance, eventually broke the bond between religion and science. This period is known as the Enlightenment. There was a commonly held belief that mankind was emerging from centuries of darkness into an new age of reason, science and human self interest. The Enlightenment opened society up to a new, demystified, rational world where man's ability to reason would reign supreme. Society, no longer encumbered by social taboos, explored the world and its phenomenon. The Church, traditionally the seat of power and wealth, began to lose hold on a society that placed greater emphasis on humanity than deity. The limits that nature imposed slowly disappeared as intellectual thinkers such as Voltaire, Rousseau and Kant helped open the door to scientific discoveries in physics, chemistry, and astrology. Rather than the study of Aristotle or the Bible, emphasis was placed on the study of nature; naturalism was a flourishing pastime of the wealthy. The pure rationality of science, it was believed, would eventually unlock all of Nature's physical laws. Scientific and technological discoveries were seamlessly integrated into the mainstream. There was no linear process between scientific discoveries and technology. It was not always necessary for laws to be discovered in the laboratory before society could benefit. Discoveries such as hydraulics and the steam engine were utilized long before their internal workings were documented scientifically. This shift in emphasis from Religion to Science should not be underestimated; it is fundamental to the birth of modern technology and to the pervasive belief that we must progress. The Enlightenment is an example of an intellectual movement within society that eventually becomes part of the social fabric. Society's institutions and structure are built around the concept of progress. Once this concept was accepted, there would be no questioning its validity or importance. In the 19th century, the instrument of progress would be technology.

The Enlightenment established the social structure that would allow the Industrial Revolution to define the 19th century. The pursuit of Nature's laws in the laboratory, and continuing mechanical experimentation, led to an explosion of physical, rather than intellectual change. Technological advancements became the pride of cities and nations, a sign of virility and progress. The promise was nothing short of human emancipation and freedom from scarcity. The goal was to provide food, shelter, clothing, health and happiness for the largest number of people possible. The advancement of assembly line production, based on the division of labour, provided mass produced goods to the public at an affordable cost. The true *cost* to society and to the environment was not measured or considered at that time. Urban centres, with their expanding industrialized economies, attracted large numbers of people who took advantage of the opportunities afforded. We have understood for some time that there is a social and environmental cost associated with the Industrial Revolution. Much of the world has yet to experience the social change that industrialization can bring, and the Third World countries often show its darker side. The panacea that industrialization promises is often at the expense of the poor and the environment. These countries do not have the social structure and environmental laws to protect the latter; consequently, the exploitation usually goes uncontested. The Industrial Revolution changed society from an agricultural one into an industrialized one. The resulting technological advancements enabled populations in the industrialized nations to rapidly increase. The patterns were set; technology enabled the economic growth on which all society now depends. Society's focus became progress, which displaced the empathy society had toward nature prior to the Industrial Revolution. This set the tone for fifty years of growth.

'The project of modernity, grounded in Enlightenment reasoning and driven by technological and industrial progress, began to show signs of faltering towards the end of the 1960's. A series of events took place at this time that challenged the long-held trust in innovation and scientific development to overcome all difficulties in the human pursuit of ever-increasing standards of life.' [4] It was in a milieu of social unrest and uncertainty that the environmental and conservation movements gained momentum and more importantly, credibility. The Energy Crisis of the 1970's demonstrated the persuasive influence of technology on our daily lives. It highlighted the fact that the *fuel*, both literally and figuratively, of our economic growth was controlled by a small number of powerful entities. Multinational petrochemical companies controlled the oil supply, the most important energy source since wood. To this day the policy of these companies directly affects the daily lives of people in the industrialized world. The oil crisis was a result of the Arab - Israeli War, in which the Arabic oil producing countries embargoed oil shipments to the United States. The resulting oil shortage in the United States prompted some of the OPEC countries to sell off their oil at a higher rate. This sent the industrialized world into panic, as the price of a barrel of oil soared to eight times its previous cost. It was this perceived oil 'shortage' that sparked the wide ranging energy conservation movements. Cars became smaller, buildings became heavily insulated with fewer windows, and there was a massive advertising campaign to 'turn off the lights'. The technology that promised society freedom from scarcity and toil, had enslaved it; *'men have become the tools of their tools.'* [5]

Through world wide media coverage, and fresh views of the planet from space, environmental issues became culturally relevant in the 1960's. Newly formed groups such as Greenpeace became crusaders against any entity that was exploiting or senselessly damaging the environment. Formed in the early 1970's to protest nuclear bomb testing, Greenpeace became heavily involved in the 'Save the Whales' campaign and protested the clubbing of baby Harp Seals in Newfoundland. It was the aggressive, media savvy style that made Greenpeace the vanguard of environmental activists in the 1970's. They were *doing* something, and the world noticed. Environmental agendas became part of political platforms. The first Green Party to take an environmental platform to the poll was the German Green Party (Di Grunen). Di Grunen now has a twenty year history that enables it to participate in the formation of public policy. This, in part, explains why the Germans are the world leaders in energy conscious technology. The biggest challenge these Green parties face is the promotion of conservation in a system designed for progress.

Conservation, as a concept, is not new and has likely been in existence in some form since the beginning of civilization. In the mid 1800's naturalist authors like Henry David Thoreau openly discussed the wonders of nature and man's relation to it. Thoreau assessed the true value of an object in terms other than its monetary value: *'the cost of a thing is the amount of* *what I will call life which is required to be exchanged for it, immediately or in the long run.'* [6] In an era of economic and industrial expansion, Thoreau openly wondered why he needed to work for so many years before he could own his own dwelling. He proceeded to reduce his desires to needs. In a frugal dwelling built by his own hands, he embodied the concept of conservation. Civilization's biggest dilemma is clear; there is an ever increasing demand for resources due to population increases and higher standards of living, and yet the earth's finite resources are being depleted faster than they can be replenished. The quantity of resource extraction, production, and export must not be the only measures of economic success; the economic system must assess the social and environmental impact of progress. *'The economy put no price tag on resource drawdowns or on pollution, it gave no incentive to extract sustainably, process cleanly, or optimize use.'* [7] We must find a new way of assessing value. A more holistic approach is required that considers all the factors involved. Social and environmental costs should be accounted for.

The transition from intellectual movement to social agenda is necessarily a slow process. It is analogous to the formation of law; the issue must be challenged and debated in order to test its validity and relevance. The conservation movement that gained momentum in the early 1970's has become part of the social fabric of the industrialized nations; it now resides under the popular term of Sustainability, symbolized by the colour green. A Green Agenda pervades every major social institution and level of government, and yet the industrialized world is very slow to change its well established modus operandi. Our technology is still directed towards self-perpetuating expansion, which creates a dependency highlighted only in times of crisis. *'What needs to be emphasized is that technologies are developed and used within a particular social, economic, and political context. They arise out of a social structure, they are grafted on to it, and they may reinforce it or destroy it, often in ways that are neither foreseen nor foreseeable.'* [8]

3.2 Accepting Technology without Question

Technology is pervasive. It is so ingrained in our way of living that it is not questioned. Because technology is such an integral part of our lives, changing it or questioning it becomes very difficult. Any deviation from the norm is critiqued *against* the norm, which is perceived as the only way of 'doing it'. New technological approaches must overcome the stereotypical criticisms of being 'inefficient' or 'counterproductive'. These criticisms are rooted in the current economic systems which give no credit for sustainable or environmentally sound practices. We can not picture a world without technology. It has the ability to *'reorder and restructure social relations, not only affecting the relations between social groups, but also the relations between nations and individuals, and between all of us and our environment. To a new generation, many of these changed relationships appear so normal, so inevitable, that they are taken as given and are not questioned.'* [9] Social unrest in the 1960's was directed at social injustices, Vietnam, and the environmental degradation. The idea of 'Peace and Love' was represented by a harmonious relationship with nature and communal living. By simplifying their lifestyles, questioning society's structure and values, the 1960's movement was indirectly questioning the role of technology in society.

3.3 Social Agenda as the Director of Technology

A social agenda is a set of values or opinions that the majority of society shares. It shapes our culture and directs our technology. Our relationship with technology describes our humanity; it marks our distinction from the Animal Kingdom and describes our relationship with nature. Architecture is the physical history of this relationship. The relationship between society and technology is not a simple cause and effect relationship. Once established, technology can influence society both negatively and positively, with its often extraordinary capabilities. Left unchallenged, technology becomes the fuel of consumption; a self-perpetuating phenomenon aided by sophisticated advertising campaigns, government policies, and built-in obsolescence. But technology's fundamental direction is generated by the society it serves. The inception of a new technology is directly related to the combination of prevailing social, political, or environmental forces in any given society at any given time. We are now struggling with our outdated mode of technology in the face of global environmental challenges.

3.4 Technology as Social Savior

We have used technology since our conception; it is the manifestation of our ability to reason. *'Technology has built the house in which we all live. The house is continually being extended and remodeled. More and more of human life take place within its walls, so that today there is hardly any human activity that does not occur within this house. All are affected by the design of the house, by the division of its space, by the location of its doors and walls. Compared to people in earlier times, we rarely have a chance to live outside this house. And the house is still changing; it is still being built as well as being demolished.'* [10] Traditionally, we have used technology to feed us, clothe us, and protect us from nature's elements. Technology has improved the living conditions for most individuals in the industrialized world. Third World countries are currently pursuing the same standard of living. We use technology to 'better' civilization, to probe and exploit nature's wonders, to delve into the human body and cure all our ills, to explore the universe, and to solve all our challenges and problems. Yet it is clear that the direction of technology we set in the industrial revolution must change in order to ensure our survival. We must expand the boundaries of technology in order to solve our current problems. In effect, technology needs to be popped out of its 'box'. The current environmental crisis can not be solved by machine based technology alone, because that model of technology is part of the current problem; *'whilst technological advances have provided better models and means of explanation regarding the detrimental effects human activity is having on the environment, it is recognized that forms of technological domination traditionally employed to over come these detrimental effects are no longer valid.'* [11]

3.5 Faceless Aspects of Technology

Most people only experience the end result of technology, usually a product or service. The technology that enables the end result is usually viewed as cold and mechanistic. The machine is ruthless in its logic. It does the drudgery for society. It is not biological, and yet it wields immense influence; it threatens physically with its power, and intellectually with its control. The masses do not consider machines beautiful. *'Technology is the making of things and the making of things can't by its own nature be ugly or there would be not possibility for beauty in the arts, which also includes the making of things.'* [12] While technology can be a beautiful work of art (e.g.. BMW or Apple G4), beauty is not a technical requirement, but should be an intellectual one. Beauty is typically a veneer of style that is meant to disguise, thereby elevating the object from lowly rank of 'machine'. The machine would work just as well without its beautiful container, so the real ugliness is in the relationship between us and technology; are we ashamed of our technology? *'What's wrong with technology is that it's not connected in any real way with matters of the spirit and the heart. And so it does blind, ugly things quite by accident and gets hated for that.'* [13] Technology is faceless and mute; it is the instrument we use to shape our environment. In and of itself it is innocent. Innocence means vulnerability, which unfortunately makes technology a convenient scapegoat.

3.6 Prescriptive and Holistic Technology

In her CBC Massey Lectures Series, Ursula Franklin defines two modes of technology, Prescriptive and Holistic. The lectures are an investigation into how things are being done, not what is being done. We utilize, almost exclusively, the Prescriptive mode. It is defined as specialization by *process*, whereas the Holistic mode is defined as specialization by *product*. Prescriptive and Holistic technologies both involve working with other people. In the Holistic mode the worker is in control of the entire process, not just a portion of it. Prescriptive technology is based on the division of labor, where an individual is responsible for a well defined, *prescribed* task that is part of a larger process. In the Holistic mode the artisan controls the work, making decisions along the way based on experience. *'Any tasks that require caring, whether for people or nature, any tasks that require immediate feedback and adjustment, are best done holistically. Such tasks cannot be planned, coordinated, and controlled the way prescriptive tasks must be.'* [14] Whoever prescribes the rules holds the power. When you are only responsible for part of process, and have no control over the outcome of your task, you do not have the ability to easily affect the end result. The Prescriptive method is not restricted to production; it is ingrained in our social, political, and economic systems as well. It is what makes change so difficult. *'While we should not forget that these prescriptive technologies are often exceedingly effective and efficient, they come with an enormous social mortgage. The mortgage means that we live in a culture of compliance, what we are ever more conditioned to accept orthodoxy as normal, and to accept that there is only one way of doing 'it'.'* [15] While we have been able to develop a wide variety of technology within this context, the macro approach to the development of technology has been narrow.

3.7 The Role of Government, Divisible and Indivisible Benefits

By controlling infrastructure, the government has ensured its role in the development and control of technology. With that control comes responsibility. The startling technological advances of the last century could not have happened without the support of government, and their large scale infrastructure programs. *'Here one wants to consider in the first place the technology of transport - moving raw materials and final products along the road, rail, air, and water, as well as moving energy and information from points of generation to points of use.'* [16] Politically, it is a relationship that benefits industry and society as a whole. Industry benefits from the provision of infrastructure that it requires in order to create and distribute products. Society benefits from job opportunities and from the supply of inexpensive domestic infrastructure. Electricity can be used as and example. Once it was introduced into society, the planning and provision of affordable electricity to industry became a competitive occupation of governments. Industry would move to the area where there was a reliable source of electricity, jobs would be created and the economy would grow. Society profited through the government's infrastructure policies; consequently, the voting public became more inclined to re-elect a growth oriented governments. Government decisions are typically based on short-term gain. They need to demonstrate progress within their political term, or face expulsion from office; not a great system when you consider the complexity of the system they are managing. When this type of political and economic system was developed, nature was viewed as a resource without boundaries. Governments quickly discovered that they could lure industry with infrastructure; this technique has now been expanded to include tax incentives, benefits, and the relaxation of environmental regulations. The link between technology and government must be stressed, because government can heavily influence technology on a macro scale. *'Rarely are there public discussions about the merits or problems of adopting a particular technology. For example Canadians have never been asked (for instance, through a bill before the House of Commons) whether they are prepared to spend their taxes to develop, manufacture, and market nuclear reactors.'* [17] Without the government support of infrastructure, loans, marketing and subsidies Canadian Nuclear Power would not exist. *'Our perceived need for technology is mostly generated by the competition of countries for export, I think it's economies, not people, that need devices in order to grow.'* [18]

Governments must fulfill their responsibility for safeguarding the benefits that technology brings. They must protect the indivisible benefits of technology for the societies they serve. There are two types of benefits, indivisible and divisible. Ursula Franklin defines an *indivisible benefit* as a benefit that can be shared by all, such as justice and clean drinking water. A *divisible benefit* is one in which only the immediate parties involved benefit, such as the sharing of profits in a company. By being involved with the creation and delivery of technology, the government runs the risk of its policies deteriorating into divisible benefits, in which only certain portions of society benefit, especially sectoral industrial leaders. The system of infrastructure that society has paid for through taxation can become the vehicle of social and environmental degradation. *'The public purse has provided the wherewithal from which the private sector derives the divisible benefits, while at the same time the realm from which the indivisible benefits are derived has deteriorated and often remains unprotected.'* [19]

3.8 The Green Consumer and Industrial Ecology

There is no doubt that the holder of technology has the power to influence and direct society, and yet the values they hold simply reflect our own. In theory, those values will change with the prevailing social agenda; this is why Corporate America is 'greening' itself. It is constantly researching the opinion and mood of the consumer; their survival depends on the information they glean, and how they use it. Governments should take advantage of that information, because it is quite possible that Nike, for example, knows the general population better than the elected government. Knowledge and autonomy allow corporations to react faster.

'What really sent corporate America back to the drawing board in the nineties was the greening of its customers.' [20] There are no altruistic corporations; it is the educated consumer driving the pace of change. People are more aware of what they are buying, where it was made, how it was made, and what it is made of. More importantly people are willing to change their lifestyles to accomplish these changes, in this case the agent of change is the dollar; nothing gets industry's attention faster. Driven by the society they serve, all the major corporations are beginning to practice Industrial Ecology. The basic tenant of Industrial Ecology is that *'we should try, wherever possible, to work only with substances that nature would recognize and be able to assimilate.'* [21] It has taken us one hundred years to re-discover this basic principle; however, for large multinational corporations this is a radical concept. The Ford Motor Company, for example, has a two page colour advertisement in National Geographic depicting its new 'green' automobile plant; essentially they are doing everything in their power to be a good corporate citizen. They are constructing a new plant / research facility that will explore environmentally sensitive manufacturing practices, and alternative energy sources to power the plant. They intend to make their findings public, and available to their competition. Theoretically we will like their commitment to making the world a better place and buy their cars (ironically). If this was not the case, they would have 'greened' themselves long before it became socially important. The interesting point regarding this phenomenon is that society, and more importantly the environment, does benefit. It could be argued that Ford is simply responding to another market trend, and adjusting their company accordingly. Even if this were true, there is still an indivisible benefit for society. It is as close to altruism as you can get in our economic and social system. Ford is doing something positive for the environment, in the hopes of maintaining its public image and ensuring future profits. Only time will tell if it is truly a win-win situation.

The 'greening' of society does not stop at the corporate level. Our social institutions are also concerned with the environment. We are seeing the birth of new educational centres that are dedicated to the study and research of sustainability. Their scope of study is as broad as possible, and therefore the mixing of different disciplines becomes an advantage. These new centres, such as SDRI at the University of British Columbia, do not merely study the cause and effect of environmental degradation; they focus on what the desired ecological, social and economic culture is and try to design policies that will ensure this future. The complexity of the issues demands a new form of study and research.

3.9 The Future Role of Technology

Thus far, we have employed technology to help us overcome and dominate nature. The short coming of this relationship is now very evident. Ironically, it is through technology that we better understand our impact on the environment. Clearly our current mode of technology will not be able to adequately solve the problems that face us, assuming that the relentless pursuit of progress continues. As in the past, technology will play a critical role in re-defining our relationship with nature; *'indeed, it may be argued that the increasingly dialectical relationship between our understanding of the environment and technology will be a defining factor of the new solar age.'* [22] Through the 'green' social agenda, we have re-directed technology towards the inclusion of the natural world in its operations and investigations. It is a more holistic approach to the issues at hand. When all the variables are considered, the true *cost* of technology emerges. Our machine based model for technology, pioneered in the Industrial Revolution, is gradually giving way to a nature based model. We are slowly turning our technological attention to natural phenomena, the mundane events that happen daily in the natural world. From the Stone Age, to the Bronze Age, to the Iron Age, to the Silicon Age, and now to the Solar Age.

4.0 Architecture in Relation to Technology

4.1 The Systems of Architecture

Fire can be viewed as *'the major invention that ultimately led human kind to become independent from natural conditions and cycles, through artificial light and heat, but also as the first major step of active energy conversion constantly requiring resources.'* [23] We are in the midst of taking the next step in the evolution of our technology, historically architecture has followed suit. Architecture again mirrors the significant social and technological changes currently afoot in society, changes that were set in motion in the 1960's. The systems of architecture, meaning the technology that architects employ, are manifestations of technological and environmental attitudes. Historically, they have represented the state of the art and consequently, the level of technological sophistication of that culture. Currently, architectural systems typically do not represent the state of the art, but an acceptable level of service that is the least expensive. The vanguard client is rare. As a result, the building industry is extremely slow in adopting new technologies.

The systems of architecture also represent our relationship with nature, in a very direct non rhetorical way. The architectural systems employed will reveal the relationship between man and nature as parasitic, commensal or symbiotic. For example, the air conditioned glass pavilion represents a parasitic relationship; the energy consuming systems (machine based) embodied in the formal architectural language are deliberately foreign to the landscape. It is a one way relationship; the landscape enjoys no benefit. Man's relationship with nature, in this example, is parasitic. A commensal relationship would be represented by a glass pavilion that utilizes passive strategies to cool the interior. In this example, man benefits from nature's energy, while nature remains unchanged. The difference in these two examples is the direction and emphasis of the technology. As mentioned earlier, this emphasis is a result of the prevailing social attitude towards nature, explicit or implicit. In the parasitic example, technology is employed to conquer the heat gain inherent in a glass box. In the commensal example, technology is employed to harness natural phenomena, and to ease our impact on the environment. A symbiotic relationship is one in which both parities benefit. It is difficult to ever see nature benefitting from man's intrusion, even if our technology is sympathetic. Our symbiotic relationship with nature ended with the advent of fire.

4.2 Machine Based Technologies

A machine is an apparatus or system that applies and directs mechanical energy toward a specific objective. The machine has been the model and inspiration of our technology since we first began to use tools. Without a common philosophical base, new technologies would not have developed as quickly. What we have are variations of a theme. Thus far, the scope of our technology has been narrow, which is also why it has been so successful. *'We feel powerful, but what we've really done is trade away our power for control. To make sure only one thing happens at a time, we've frozen out all interactions and side effects, even those that could be beneficial or brilliant. As a result we have a machine that is thoroughly dead - inefficient, inflexible, and doomed by the limits of Newtonian physics.'* [24] By excluding other models, we have limited the potential of technology.

The Industrial Revolution cemented the relationship between the machine and technology. Up until that time, the machine played a minor role in the economy and in architecture. While there were machines (wind mills and water powered mills) they lacked *power*. Once the machine was imbued with power everything changed. There has never been a more significant change to society, the only comparison is the Neolithic revolution, where the structure of society changed from hunter-gather to a communal structure. Because the Industrial Revolution affected the structure of society, it inevitably affected architecture. Prior to the Industrial Revolution, the systems of architecture relied on the empirical data collected and passed down from generation to generation. New materials and technologies forever changed the way a building works, in particular the advent of electricity.

As the 19th century came to a close, architecture was in the midst of change. It was reflecting the social change resulting from the Enlightenment. Architecture began to emerge from the mid-century stylistic quagmire. A clear example of this conflict was the newly invented train station shed, fronted by a neoclassical facade. The birth of Modern architecture was propelled by new technologies. Building Science became be a new branch of architecture and engineering dedicated to servicing the building interior, with the aim of providing comfort in all seasons and all climates. The science of engineering, mechanical and structural, had a major impact on Modern architecture. The unprecedented architectural forms of Modernism created internal comfort problems. Technology was employed to solve the problems of heat loss and heat gain in the physically lighter, heavily glazed buildings. Technology permitted a clean break with the architectural systems of the past. The established modes of structure and environmental control were superceded by new technology, inspired by architectural form, and vice versa.

Le Corbusier was a pioneer in creating and solving the problems of internal comfort in Modern architecture. His City of Refuge, built in Paris in 1936, is an excellent example. The lessons learned from this project would eventually inform his treatment of facades, and how he designed in different climates and countries. The project has an entirely glazed south facade. Between the glazed south facade and the interior of the building, Le Corbusier designed, in conjunction with glass manufacturer Saint Gobain, the Mur Neutralise. It was the prototypical double facade. It treated the cavity between the interior and exterior of the building with cool or warm air, depending on the outside temperature. Due to high costs, this device was not installed in the building, leaving it with a hermetically sealed south facade which created unbearable indoor environmental conditions in winter and summer. The building was eventually retrofitted with Brise Soleil (ironically a passive system). Le Corbusier exemplified the pioneering spirit of the times, which was also represented in the Futurist Manifesto and in the teachings of the Bauhaus. Modernism embraced technology, glorified it, and incorporated it into its aesthetic. The architectural acceptance of technology was the dogmatic key to the concept of being *Modern*. Architecture reflected a society which had also accepted technology, and placed great faith in its abilities.

'The Industrial Revolution heralded the pursuit of progress and innovation dictated by a human desire to do away with our dependence upon natural constraints, and in so doing, to overcome and dominate nature. Rather than working with particular environmental qualities, buildings have increasingly come to represent enclosed, isolated boxes in which the internal environment is artificially controlled.' [25] As the Modern Movement grew older, it was accepted on a global scale, best symbolized by the advent of the skyscraper. As a vertical extrusion of glass, it requires continuous heating, cooling and lighting. Its main strengths are its efficiency and iconic value. It is still a symbol of progress, economic wealth, and modernity that proffers today regardless of climate and context. The severed relationship between architectural form and climate is analogous to the estranged relationship between industrialized man and nature. The architecture, and its associated systems, are a built testimony to that relationship.

4.3 Nature Based Technologies

'Fire was fine for a while - it kept us warm and cooked our meat. The problem is, we've never gone beyond fire, combustion in furnaces or in engines is still the primary egg in our energy-producing basket, and it hasn't brought us one inch closer to living sustainably.' [26] At a macro scale the architectural systems of Modernism are ones of domination, technologies born of, or utilizing fossil fuels to attain their desired goals. They were products of their time and have revolutionized the expected level of comfort in buildings. The pre-industrial model utilized nature based technologies towards the same goal, a comfortable shelter; however, the definition of comfort was very different. The internal conditions varied with the external conditions, as opposed to the homogeneity of the machine based systems. The primary motivation to build was shelter, implying comfort and safety from nature's elements. *'Our first building structures provided simple protection from uncomfortable temperature extremes, and until fairly recently a large majority of people spent much of their lives outside, rather than within, buildings.'* [27] Our first buildings were inherently green; they were integral to their context. Their architectural systems were nature based, meaning they interacted with the environment in a passive way; they harnessed rather than conquered. Nature based technologies utilize nature's free forces to their advantage. The concepts are well understood, but their importance has been overshadowed by the industrialization of architecture. Thermal mass was used for heat storage; shading devices were used to keep out the harsh sun; natural ventilation kept the interior cool, and day lighting kept the interior bright. The building materials were local, and renewable. The solutions to the problems of shelter and comfort evolved locally, and therefore the architecture came to represent that climate and culture. The most critical element to the development of indigenous architecture was the quantity and severity of the sun. The architectural differences between a watery nordic climate and a humid tropical climate are drastic. Architectural forms were driven by context.

'What of architectural beauty I now see, I know has gradually grown from within outward, out of the necessities and character of the indweller, who is the only builder, out of some unconscious truthfulness, and nobleness without ever a thought for the appearance; and whatever additional beauty of this kind is destined to be produced will be preceded by a like unconscious beauty of life.' [28]

After the Industrial Revolution, there were architects who pursued a balance between man, nature and technology in their architecture. Le Corbusier pioneered the Brise Soleil, and his later work reflected a sympathetic approach to context and climate. The Sarabhai and Shodhan houses in India show sensitivity to shade and ventilation in their siting, massing and facade compositions. Although modern in appearance, these two houses were decidedly 'low tech'. Frank Lloyd Wright's architecture also displayed a sensitivity towards climate. From the low slung earthworks of Taliesin West in Arizona to the horizontal glass striations of Falling Water in Pennsylvania, the architectural form reflected the climate. These fine buildings were exceptions as *'buildings came increasingly to represent a* *submittance to the control of technology itself rather than the use of technology as a tool for architecture.'* [29]

It was not until after the Energy Crisis in 1973 that architectural form began to reflect society's new found concern over energy consumption. In the commercial sector, the results were deeper plans with heavier wall construction, fewer windows and tighter envelopes. They typically had a better cladding to floor area ratio than their thin, slab on podium predecessors. Refinements in mechanical systems allowed heat exchangers to recover waste heat from artificial lighting, which was necessitated by the deep plan. However, the basic technological model was not questioned. In general, there was a refinement of the machine based technology. In most urban settings, the hermetically sealed glass and steel box became the only option. Although these buildings used less energy overall, they created internal atmospheres completely disconnected with the outside world. The artificiality of the interior created unpleasant working conditions. If these systems were in poor maintenance, they could cause health problems; Sick Building Syndrome is the sign of utter architectural failure.

The 1980's once again saw architecture in stylistic upheaval. The previous building envelope and mechanical improvements were carried forward. However, energy consumption was not a topical issue in a decade of unprecedented consumption. Advances in technology allowed unprecedented access to the earth's envelope; the depletion of the ozone layer boosted the already established environmental movement. In the 1990's the global community became involved in the environmental crusade; once again energy consumption would be topical in architecture.

In recent years, architecture has move beyond mere efficiency. Architects such as Rogers, Foster and Piano extrapolate local building traditions and techniques and reinvigorate them with technology. They have been producing site sensitive architecture, that is also culturally relevant. To call it 'green architecture' would over simplify their accomplishments; it is architecture in its fullest sense. They fuse history, technology and nature into a cohesive whole that transcends labels and stereotypes. The architectural systems they employ challenge and question convention. Consequently, the energy sources for the buildings have also been questioned. The refinement and rediscovery of natural systems has allowed buildings to become energy contributors rather than consumers; this is possible today with technology that is decades old. The goal is simply to provide the same level of internal comfort without using as much energy. In most cases, it could be argued that the internal environment is more satisfying both physically and mentally. European architects are world leaders in architecture that incorporates nature based technologies. This is due mainly to their stringent energy laws, which have revolutionized their construction industry. Out of their temperate European climate, common environmental strategies have emerged in a variety of forms. The prototypical building consists of a narrow floor plate that maximizes day light, solid elements that act as thermal storage, internal planting that enhances air quality, atriums that ventilate and illuminate floor plates, and dynamic glass facades that moderate between the internal and external environments.

The user is expected to participate in the tuning of these systems. Because the envelopes of these buildings rely on natural ventilation, the occupant is expected to open and close the windows when required. At a modest level, this allows the users some connections with the outside world, and some control over their local environment. The assumption is that a person can regulate his or her environment better than a machine, with less waste. This requires a certain degree of education on the part of the user. They are forced to interact with the architecture, something which mechanized systems avoid (e.g. thermostat under lock and key). Some of the more sophisticated systems have computer overrides that take control when exterior conditions become extreme. It is paradoxical to have fully automated natural systems; they are fusions of two different types of technology. This hybrid technology is designed to maximize nature's potential. This exemplifies the shift from machine based technology to nature based technology. The output may be the same or better, but the mode of delivery has, and will continue to change. The rediscovery and refinement of natural systems is the first step in a larger investigation of nature's inner workings, one that will expand the definition of nature based technology and provide an alternate technological model.

4.4 Biomimicry - The Future Technological Model

The formal leap that is powering the current technological revolution is commonly referred to as Biomimicry. The term was coined by science writer Janine Benyus in her book *'Biomimicry, Innovation Inspired by Nature.'* Biomimicry is the study of nature's models with a view to exploration and understanding, as opposed to extraction and consumption. Our future depends on a better understanding of our environment and how we can fit into it. *'Nature has evolved systems over billions of years that work in harmony with each other, that build from bare, rocky, thin soil to lush green forests. Without human intervention the processes of nature have evolved self-regulating forces of beauty, grace, and efficiency. Our challenge is to learn how to honor them and be inspired by their truth to create new cultural values and systems.'* [30] Our human civilization has created a parallel system to nature's. By any measure, our accomplishments as a species have been striking. Unfortunately these accomplishments usually involved beating nature into submission.

'Nature runs on sunlight.
Nature uses only the energy it needs.
Nature fits form to function.
Nature recycles everything.
Nature rewards cooperation.
Nature banks on diversity.
Nature demands local expertise.
Nature curbs excesses from within.
Nature taps the power of limits.' [31]

If our technology and civilization had to operate within these parameters, it would not and could not work. Our technology pales in comparison to nature's, and yet our technology has the ability to dissect nature's. *'At its best Biomimicry should take us aback, make us more humble, and put us in the learner's chair, seeking to discover and emulate instead of invent.'* [32] Biomimicry is all around us and conceptually is not new (for example the airplane and velcro). In fact it seems obvious that we would glean inspiration and information from nature; however, as a course of study, it has only just begun to penetrate disciplines of Computer Science, Agriculture, Physics, Architecture, Engineering, Medicine, Chemistry and most importantly Biology. *'Many scientists, especially those in the ecological sciences, have become students of the whole once again. Attitudes toward nature have also come full circle, reanimating life and restoring reverence to our relationship with the natural world.'* [33] We have not allied ourselves with the natural process of life on earth, which resulted in our machine based technological model; we chose to invent rather than emulate. Biomimicry and Sustainability are about asking new questions, or posing old questions in different ways. *'Why shouldn't human communities run on sunlight and recycle materials the way natural communities do? Why can't our home places be sustainable instead of simply being quarries to be mined by the extractive economy and then abandoned?'* [34]

Biomimicry will make the term 'green' seem archaic (archaic defined as an early period of culture). We are currently in the transitional phase, where our machine based architectural systems are becoming mixed with our original nature based architectural systems. It is analogous to the hybrid automobiles we see on the road now; they are also transitions between technologies. In an architectural context, the word mimic is perceived negatively. It implies a lack of originality; in other words, nothing good can come from 'copying'. This refers in particular to the mimicry of formal gestures; architectural principles such as proportion, massing, and scale resist this criticism because they transcend formal gestures. To make architectural form look like nature is not Biomimicry; it is merely the mimicry of form. The idea is to mimic nature's underlying principles, in order to understand how we can accomplish the same result with the same means. For example, we can keep the interior of a building at exactly 87 degrees Fahrenheit, and a termite can keep the inside of its mound at exactly 87 degrees Fahrenheit, but the means are very different. The termite achieves its environmental control by constantly tuning the mound to the changing climatic conditions. They block off vents, reopen others, and urinate at the top of the mound for additional evaporative cooling. They must all innately understand how this process works, because it takes thousands of them to accomplish the desired temperature. They do it all in their locale, naturally, without the benefit of power. The termite mound is a natural systems marvel, and yet we have not spent much time studying how it works until recently. Obviously, not all buildings should look like termite mounds, but there are ventilation and cooling principles there that could influence architectural form. It is a different way of thinking, a different way of attacking a problem. In this mode of thinking, nature presents alternate solutions that will enable us to change our machine based habits. *'Once we see nature as a mentor, our relationship with the living world changes.'* [35]

4.5 Nature Inspired Materials and Technologies

Biomimicry represents the ultimate fusion of man's technology and nature's invention. It is technology learning to do and act as nature does, within her constraints not ours. The possibilities are endless. Currently there are scientific teams trying to unlock the secrets inherent in spider silk, abalone shells, mussel adhesives, rhinoceros horn, and nature's ability to self assemble. It is a path fraught with danger, ethical danger. Although the unlocking of nature's construction secrets promises more durable, stronger, natural materials, we must have restraint in the pursuit. Without restraint, nature will again be treated as a resource. The concept of 'resources' is man made; nature does not stock-pile materials as assets. There are already examples of exploitation; for example, the genetically modified goats developed in Montreal to produce milk laden with spider silk proteins. Although one may argue this is a first step, they are missing the point. How many goats would it take to produce a cable for a suspension bridge? They would need to house and feed the goats, then purify the protein out of the milk, and then spin it into a material that resembles spider silk. It is a poor man's Biomimicry, a machine based approach. In the end, steel may be just as benign.

Nature's manufacturing process is perfect, ours is not, which is the main criticism of the above mentioned process. The spider can create silk in its locale, with out heat or pressure. We should be striving for the same, not settling for solutions which are questionable and arguably cruel. We should not judge materials strictly on their physical properties; the process of getting from A to B should be just as important. We should desire the product and the process. *'Throughout history, our progress as a people has been date stamped by the types of materials we used - the Stone Age, the Bronze Age, the Iron Ages, the Plastic Age, and now, some would say, the Age of Silicon. With each epoch of civilization, we seem to have distanced ourselves further from life-derived materials and from the lesson they teach us.'* [36]

Composites are the norm in nature. The whole is stronger than the parts, because the most desirable aspect of each material is accentuated. We also utilize composites in our technological repertoire; reinforced concrete is an excellent example. The compressive strength of the concrete is combined with the tensile strength of steel resulting in an incredibly strong durable material. High performance composites usually involve large amounts of labour and energy to produce, and are therefore relegated to industries that can afford or justify their use, such as the automotive and aerospace industries. The types of composites that are readily available usually consist of fibers cast within a matrix. The material that surrounds the fibre is tightly bound to it, usually accomplished with pressure (glulam beams, glass fibre reinforced plastics). Even though our composites perform better than our monolithic materials, they are still prone to shearing and cracking. In comparison to nature's composites, ours are simplistic in their chemistry and manufacturing process. Nature uses complex chemistry with few materials; we do the opposite. Our main mode of material production involves high temperature, high pressure and strong chemical treatments. This process is know as 'heat, beat and treat'. Unlike nature, this method does not operate within any environmental constraints. *'Despite what we would call 'limits', nature manages to craft materials of a complexity and a functionality that we can only envy.'* [37]

Nature's main construction tool is chemistry. *'Biological catalysts allow nature to manufacture benignly; instead of using high heats and harsh chemicals to create or break bonds, nature manufactures at room temperature and in water. The physics of falling together and falling apart - the natural drive toward self-assembly - does all the work.'* [38] The abalone constructs its shell by secreting a polymer that self assembles into a frame resembling a long brick work pattern. The structural voids are flooded with sea water saturated with calcium and carbonate ions that eventually crystallize into solid bricks. The structural pattern is repeated on many different macroscopic levels, showing a consistent natural repetition of form. The combination of crystal and framework polymers creates and incredibly strong material. When placed under pressure it yields rather than cracks, behaving more like a metal than a ceramic. The nacre (pearl like inner lining) of the abalone shell will out perform our best ceramics, even those on the nose of the space shuttle (this is a little embarrassing for a species that considers itself the pinnacle of evolution). The abalone produces its shell without the aid of high pressure and heat, and does it *under water.* Mimicking the process would give us a strong, durable material with low embodied energy that the earth can re-absorb at the end of its life cycle. *'Slowly but surely, we're building and information infrastructure - a knowledge base that will allow us to make materials the way nature does.'* [39]

A new era of Materials Science is upon us. The fruit of this exploration resides in the realm of speculation; what will these new materials be, how will they be made, and how will they behave? But the most important question is, will there be an equal emphasis placed on the process, which will not only make the material more desirable, but also more environmentally correct.

A speculative dream:

there may come a time when a building is grown on site
where the only foreign element to the site is man's knowledge of manipulation
where structure is self assembled into a smooth bone like material, literally rooted in the ground
where crystalline powders react with rainwater to produce membranes that are self healing
where these membranes not only shield the elements but power the building through photosynthesis
where bulk materials of fine texture and grain are grown on site in modules that facilitate assembly into wall, ceiling and floor components
where the building communicates through biological computers capable of speeds equal to the speed of thought, that have no moving parts
where the building eventually disintegrates into the ground, only to be reassembled
in the future in another form
where this method of building is known as Architecture

5.0 Typologies

5.1 Establishing Typologies

Architecturally, a 'type' is defined as an original model based on a particular set of formal or functional circumstances, distilled from a range of buildings. A type transcends form, and can not be prescribed to a particular building, even though one building may be more influential than another. Types evolve over time through combination and redefinition, but all are variations of the original type, the dwelling. The beginning of a new *'type arises at the moment at which the art of the past no longer appears to a working artist as a conditioning model.'* [40] Technology in and of itself can not create a new typology. Technology's invention, guided by society, creates new typologies (power station, hydroelectric dam). A strong social agenda is the creator of new typologies (church, museum). However, when technological and cultural changes are combined, significant changes take place in architecture which mirror those of society.

'When a "type" is determined in the practice or theory of architecture, it already has an existence as an answer to a complex of ideological, religious, or practical demands which arise in a given historical condition of whatever culture.' [41]

Modern architecture is rooted in two significant cultural facts, the Enlightenment and the Industrial Revolution. Although the influence of this era stretched beyond architecture, this period in history is the most appropriate and relevant precedent to our current cultural condition, because it is the *cause* of that condition; *'industrialization transformed the very patterns of life in country and city and led to the proliferation of new building tasks - railway stations, suburban houses, skyscrapers - for which there was no obvious convention or precedent.'* [42] It is important to note that the Industrial Revolution would not have taken place with out the Enlightenment, which was the intellectual revolution that preceded it. The technological revolution which followed, is a direct result of the deep cultural changes that resulted in man placing himself at the centre of the natural world, nature became available. It is for this reason that the changes to architecture in the 1970's, driven by the Energy Crisis, did not proliferate into a lasting architectural movement; the cultural infrastructure was not yet established, it was only a 'temporary' crisis. The Environmental Movement and Biomimetic Technology both have a strong foot hold in our current culture, and are analogous to the Enlightenment and Industrial Revolution in that their significance will result in change.

5.2 A New Typology - Architecture as Infrastructure

'*So far, we've lived by the grace of green plants, and we owe both our lives and our lifestyles to them. Consider that everything we consume, from a carrot stick to peppercorn filet, is the product of plants turning sunlight into chemical energy. Our cars, our computers, our Christmas tree lights all feed on photosynthesis as well, because the fossil fuels they use are merely the compressed remains of 600 million years' worth of plants and animals that grew their bodies with sunlight.*' [43] Technology is being directed away from a reliance on fossil fuels; in architectural terms this means independence from the 'grid'; nature based technologies will supply the means necessary to achieve this goal. The grid is infrastructure. In this context, it is a matrix of machine based technologies that is considered the foundation of our built environment. Infrastructure, traditionally designed to serve large urban centres, will be delivered on a smaller neighbourhood scale. Large corporations such as BC Hydro are already researching small scale hydroelectric power generation plants. They have lower capital costs and a smaller impact on the environment, and as a whole are more efficient because *'it takes energy to move energy.'* [44] Architecture is not only a burden on this infrastructure, it is one of the main reasons for its existence. Infrastructure's machine based technology serves society its accustomed luxuries. The amount of energy expended on services that are buried beneath our city streets is truly astounding; most do not know where the lines of power, water, waste, and communications originate or terminate. Power transformer stations and sewage treatment plants are considered urban eyesores, and are usually relegated to the fringes of the urban centre, or screened with the obligatory cedar shrub. This is a significant fact because it shields society from its reality. Do we hide our technology because it is visually ugly, or is it intellectually ugly? *'If we allow the systems we've hidden - like streams and sewers - to come back to the surface, we'll become more aware that they are important components of a living system and we'll accept more of the responsibility for managing, supporting, and restoring them.'* [45] If architectural systems were designed to supply and maintain the infrastructure that traditionally runs under our streets, a portion of our ecological footprint would be made manifest and new architectural forms and types would result. New types will emerge based on infrastructure requirements, and on traditional, functional and formal requirements. For example, 'servant types' will emerge that supply water, power, waste management, communications, and food. The 'servant type' suggests combination. For example, the 'servant type' could be combined with the 'hospital type' and 'prison type'. This combination of three archetypes utilizes the inherent efficiency of the 'servant type' as both served types require power, water, waste management, communications and food in order to operate. The 'servant type' will also become a new type in itself. If no programmatic requirement is attached to it, it becomes a centralized server of traditional, community level, infrastructure. It is the evolution and combination of the power substation and the sewage treatment plant. The combinative possibilities are endless. Over time, the successful combinations will result in the formation of new typologies

6.0 Conclusion

'Yet it will happen, and our artifacts will reflect our values and choices, as artifacts have done throughout the ages.' [46] Our technology is a built testament to our relationship with nature. The social emphasis on conservation and the environment has generated a new technological model, nature itself. A fusion of man's technology and billions years of nature's experience will result in significant changes in the near future, mirrored in architecture. Nature based technology will help sustain the current lifestyle of the industrialized nations. This, however, is a small part

of the overall scrutinizing of our social and economic structure, especially in terms of the non-industrialized countries and our continuing population growth.

Architecture has always been considered as part of civilization's infrastructure, in so much as it is served by those systems. Architecture now has the opportunity to *become* infrastructure, in a way that would compliment the physical contribution it already makes. Its independence from decentralized technologies would ease the environmental impact of new construction, and enable freedom from the limitations of these underground, decentralized services. Independence has other benefits as well. Architectural systems would no longer be a the mercy of multinational energy corporations that at times have differing agendas to those of society. Independence results in an architecture that is more integral, not relying on outside forces for the success of its performance. This will not be a 'green architecture', it will be Architecture. To fulfill its role in society as an institution, architecture must elevate itself from consumption and demonstrate that it is not only a mirror of society, but an improvement to society.

'Thus it seemed that this one hillside illustrated
the principle of all the operations of Nature.
The Maker of this earth but patented a leaf.' [47]

7.0 Endnotes

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5. Henry David Thoreau, *Walden and Civil Disobedience*, Penguin Books USA Inc., New York, 1983, p.80.

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33. Ibid., p. 236.

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40. Kate Nesbit, editor, *Theorizing a New Agenda for Architecture, An Anthology of Architectural Theory 1965-1995,* Princeton Architectural Press, New York, 1996, p.245.

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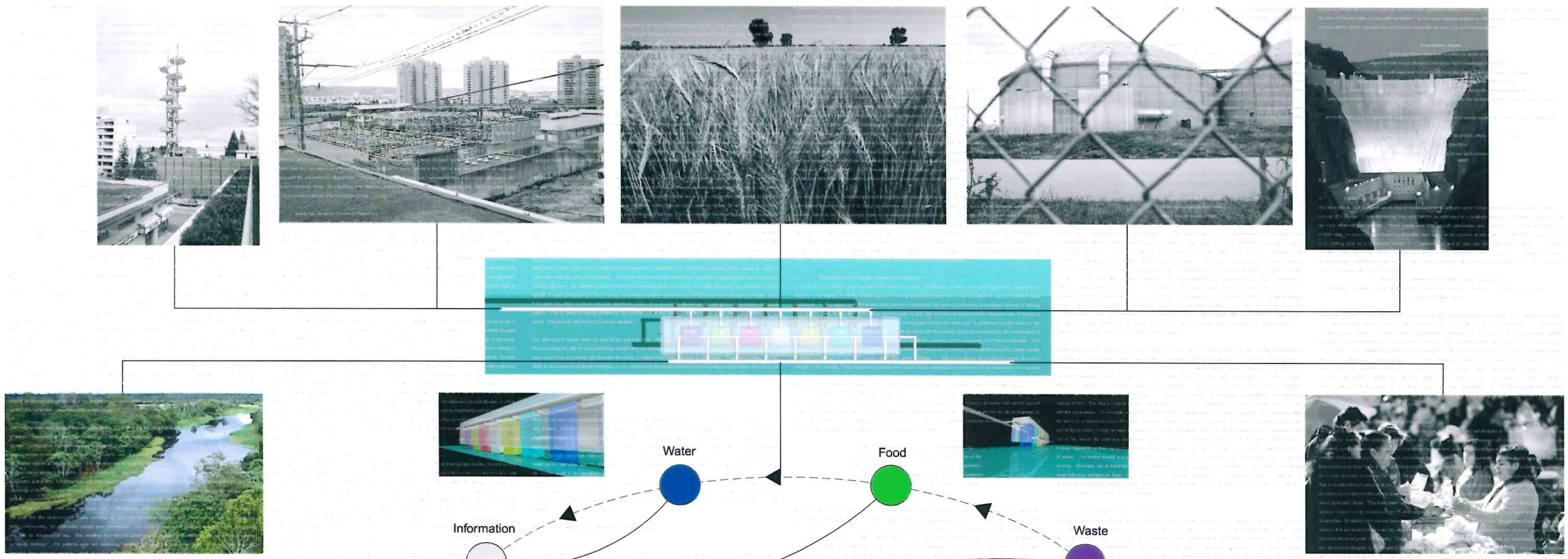
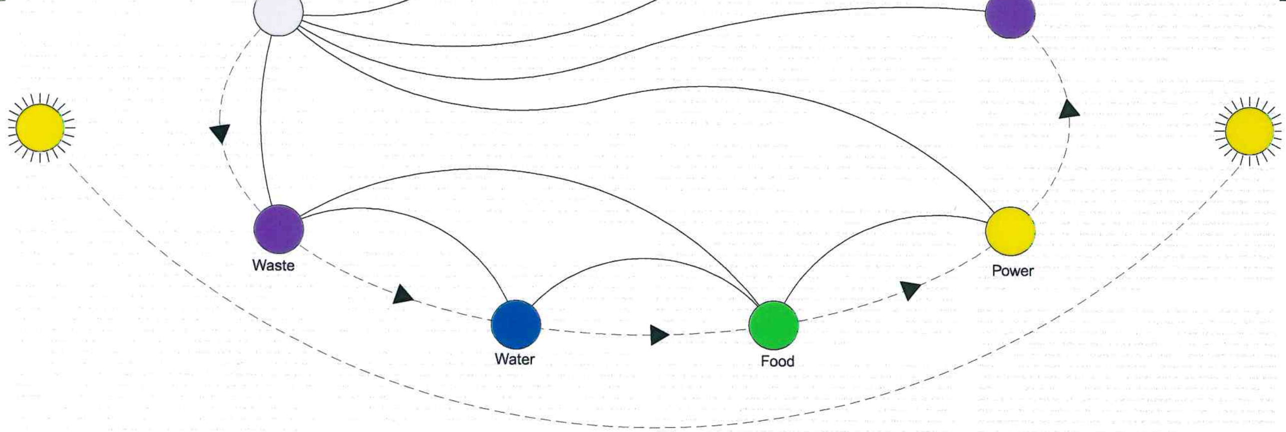




Thesis Statement:

Historically, new typologies emerge when there is a strong social agenda. When this is combined with advances or changes in technology, significant changes occur in architecture that mirror those of society. We are currently witnessing both of these phenomena. In this case, a strong environmental agenda now pervades every major social institution, while new building technologies and materials are evolving from an extensive study of nature's systems. A shift in our technological model is the thread that connects these two significant cultural facts.

Vertical Greenhouse and Heat Generation

Food growing model: Vertical Hydroponics (vegetables)
Hydroponics (fruits)
Orchard (tree fruit)

Assumptions: 190kg vegetables per person per year
120kg fruit per person per year

Vegetables

190kg x 5000 people = 950,000 kg of vegetables per year
950,000kg x .75 = 712,250kg of 'hard' vegetables
For hard vegetables 1m2 of area yields 50kg of food
Therefore: 14,245m2 of area is required

950,000kg x .25 = 237,500kg of 'leafy' vegetables
For leafy vegetables 1m2 of area yields 30kg of food
Therefore: 7,916m2 of area is required

Total: 22,000m2 of greenhouse proper (not including ancillary spaces)

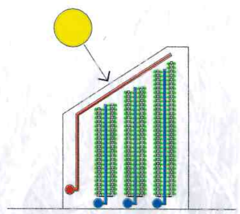
Fruit

127kg x 5000 people = 635,000 kg of vegetables per year
For greenhouse fruits 1m2 of area yields 50kg of food
Total: 12,700m2 of greenhouse proper (not including ancillary spaces)

Total: 34,700m2

The ProtoType will generate .5 the vegetables required in a quarter of the area by growing vertically, therefore the approximate area is:

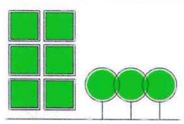
Total: **8,400 m2** + Orchard



Hydroponics and Heat Generation

Allotment Gardens and Orchard

Access to the ground plane is one of the major drawbacks of high density urban living. One hundred allotment gardens will be built into the building with enough room to grow vegetables with small storage lockers for equipment. The garden size will be a minimum of 12m2. They will be shared by the residents who wish to garden. The orchard will be the other socially oriented food growing component to the program, and will likely be mixed in with the allotment gardens. The care and harvesting of the fruit trees lends and important social dimension to the project, for those who care to participate. The area will be determined as the design progresses.

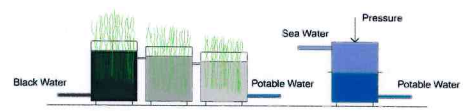


Water Supply and Solar Aquatic Biofilter

Waste Model:
Solar Aquatics, assuming a 10% loss to evaporation, and 10% of cleaned waste water used for irrigating hydroponics. The solar aquatic system not only cleans water through a series of biologically active tanks, it can also grow flowers.

Water Models:
Polished water from the Solar Aquatic system, site run-off and False Creek itself. Reverse Osmosis will be used to top up the losses in the water loop due to evaporation and hydroponics, this water will come from False Creek. Osmosis is the phenomenon of liquids within the same system seeking equilibrium. When a membrane is placed between salt water and pure water the pure water flows to the salt water in an attempt to reach the same saturation levels. Reverse osmosis places the salt water under pressure and essentially forces it through a membrane, cleaning the water in the process. There will be a large water reserve, and in case of fire the water will come from False Creek.

Area requirements: Solar Aquatics 1200m2, based on 100 litres of water per day per person.

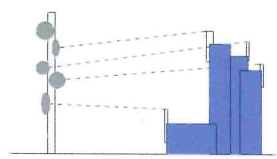


Solar Aquatics Black Water Treatment

Reverse Osmosis

Communications

The ProtoType will be the hub for wireless technologies. A communications tower will replace the typical underground telephone and cable lines, allowing companies like Telus and Rogers to experiment with new technologies.



Micro Grid Power and Heat

Energy Requirements: 12.4 GW.h per year

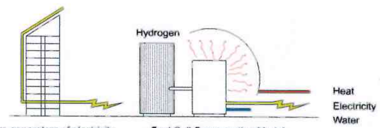
Energy Generation Model:
PV solar collection coupled with a hydrogen based cogeneration plant.

All built work will contribute to the generation of power through the use of photovoltaic glass. Using roofs and portions of the south facing building facades, it is not unreasonable to assume 100,000m2 of pv panels installed, generating 3.3 GW.h of energy. This is based on a 30% efficient panel which is the likely limit of silicon based panel technology. The raw pv power will be directed and distributed through the ProtoType's inverter, converting the dc power to ac power. Excess power will be converted into hydrogen storage.

The second part of the energy model is the district heating capability of the ProtoType. Four 250kw fuel cells, generating a possible 8 GW.h, operate in cogeneration mode, providing heat and electricity. The heat from the fuel cell will be collected and combined with the solar water collectors built into the ProtoType's greenhouse roof. This combined heat will be distributed to the individual buildings and for space and water heating. The electricity produced by the fuel cell will be used in peak, and winter hours.

The fuel cells will use hydrogen from on site biomass, on site pv power excess, and imported hydrogen generated by BC Hydro's Green Power division. BC Hydro is committed to purchasing 10% of its power from renewable sources, and they are interested in generating hydrogen in remote sources, the advantage is that the power grid does not have to be extended.

The beauty of this system is that the two systems compliment one another over the course of the year. The pv will meet the majority of the power demand in the summer when minimal heat is required. In the winter, when the sun hours are less, the cogeneration plant will provide a percentage of the electricity and the majority of heat. Overall system efficiencies can reach 60%.



Buildings are generators of electricity

Fuel Cell Cogeneration Model

Vertical Greenhouse

Plants from Biofilter tanks

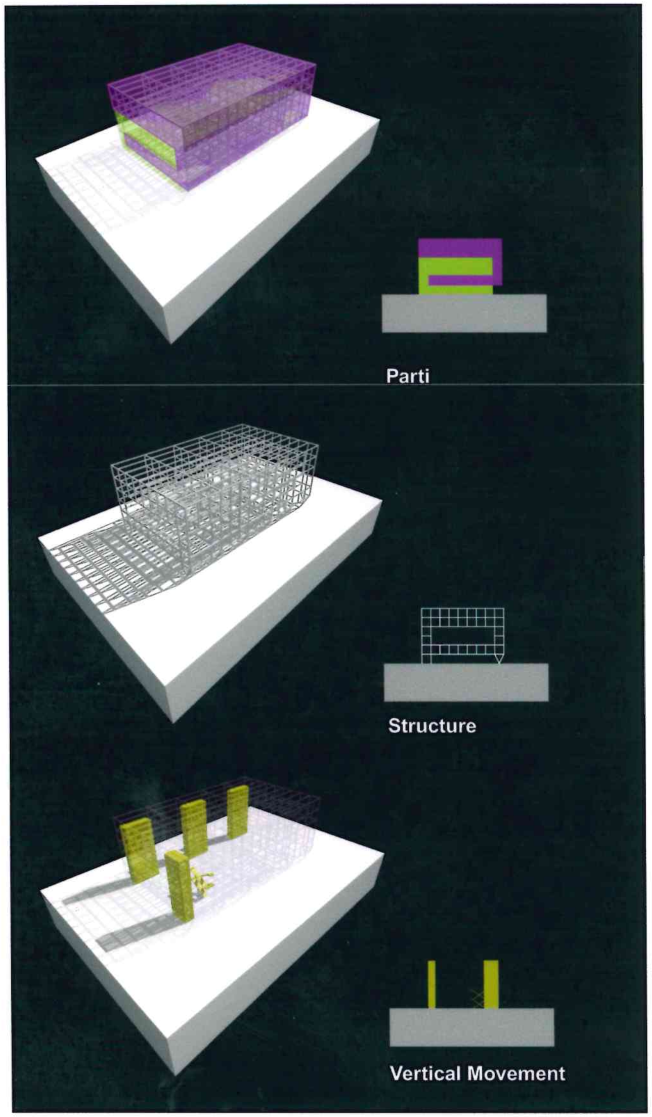
Steam Plant

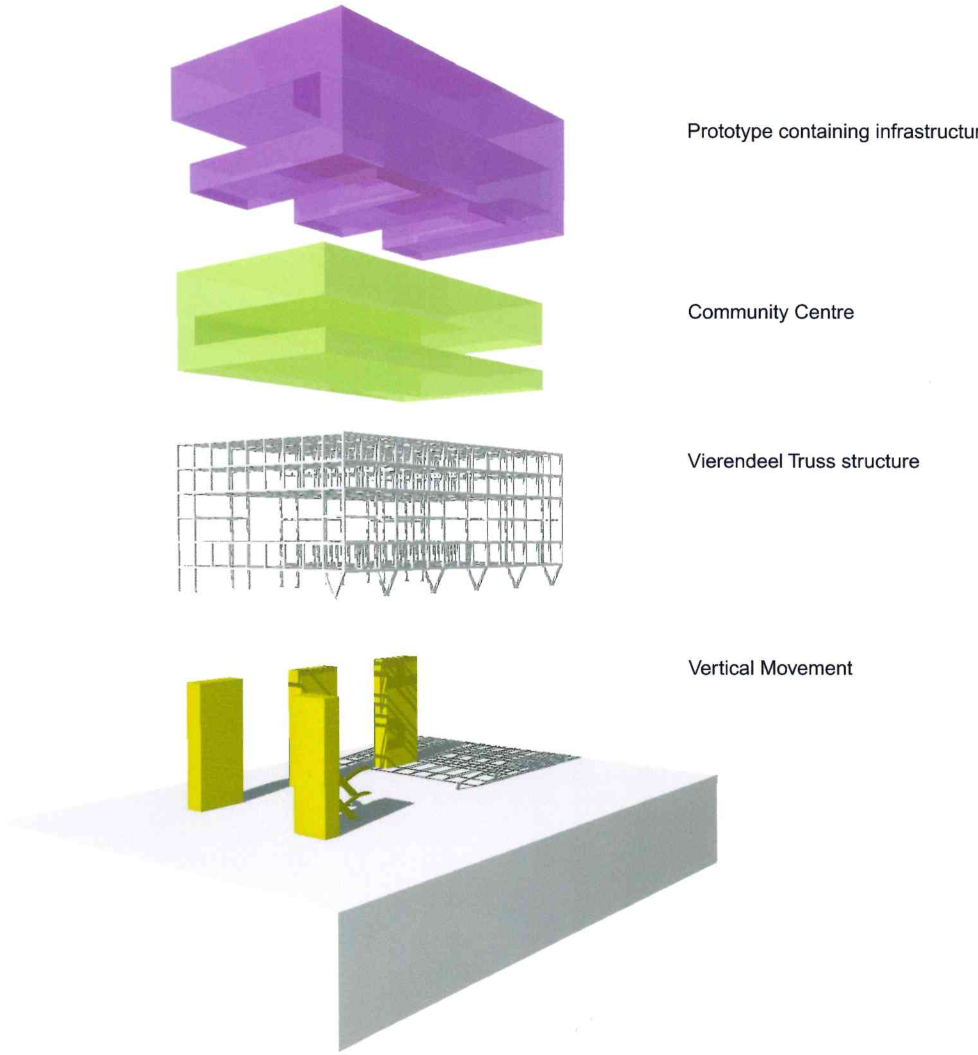
Fuel Cell

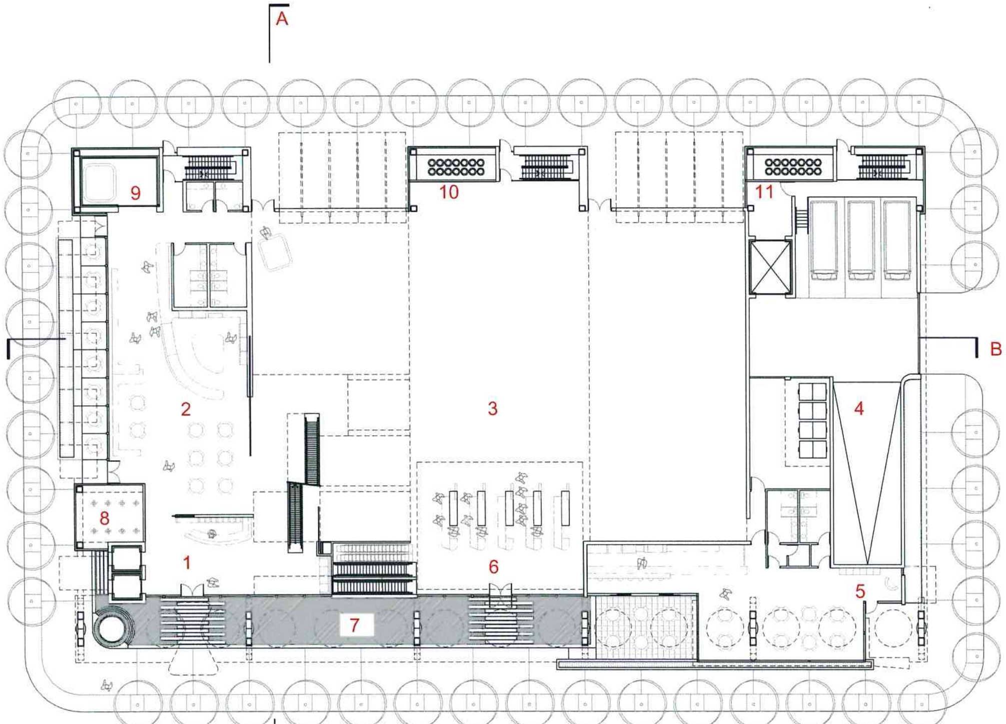
Steam Plant

	Program Element	Area m2	* Required Sunlight	Public Access	Notes
1.00	Urban Infrastructure				
1.01	Power Generation	250.00	Direct	Visual	solar hot water, photovoltaics, fuel cells and heat recovery and distribution
1.02	Water + Waste Treatment	1200.00	Direct	Visual	solar aquatic system and filters, reverse osmosis, and storage
1.03	Vertical Greenhouse	8400.00	Direct	Visual	greenhouse, collection, cleaning, biomass storage, storage,
1.04	Communications	50.00	None	Visual	communications tower for telephone and data
1.05	Control Centre	100.00	Indirect	Visual	central controls for collection and distribution
2.00	Social Infrastructure				
2.01	Market	2000.00	Indirect	Yes	entry, market, loading, storage, washrooms, café complete with exetrior public space
2.02	Lecture Hall	350.00	Flexible	Yes	200 seats, visual display, lectern, projection
2.03	Lab and Classroom	200.00	Direct	Yes	Lab and classroom facility to study the ProtoType and its relationship to the community and the environment
2.04	Meeting and Board Rooms	100.00	Flexible	Yes	Board of directors and staff meeting areas
2.05	Staff	280.00	Direct	No	8 offices
2.06	Gym and Change Room	700.00	Indirect	Yes	
2.07	Exercise Area	300.00	Direct	Yes	Views and light
2.08	Library	500.00	Indirect	Yes	Reading area to have views
2.09	Bar or Restaruant	150.00	Direct	Yes	Outdoor seating area
2.10	Loading and Parkiing	-	None	Yes	3 loading bay, 150 parking spaces
	Total Gross	14580.00			
	25% Grossing Factor	3645.00			
3.00	Total Net Area	18225.00			
4.00	Site Area	3375.00			
	Floors	5.40			

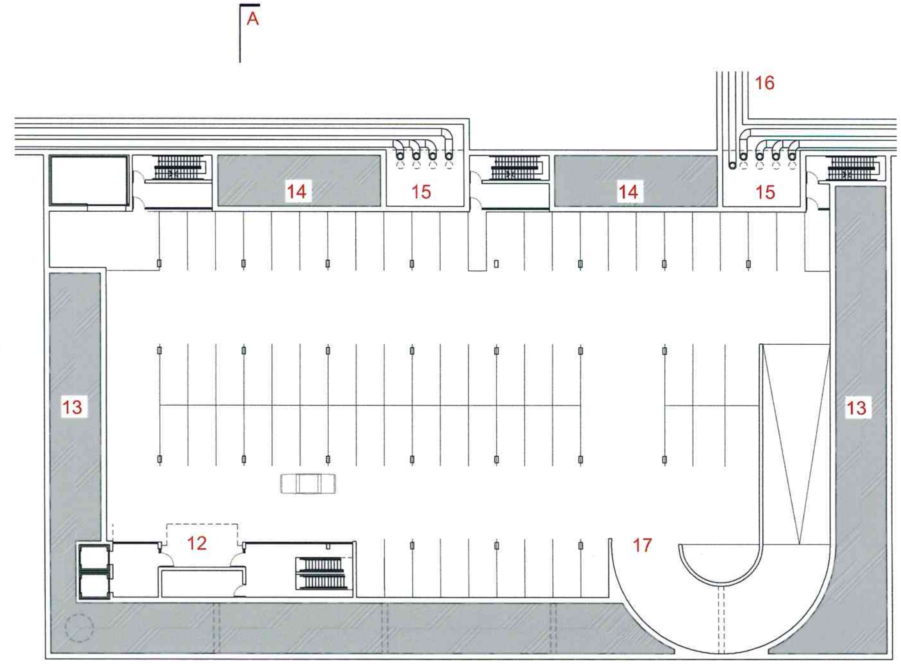
The Urban Systems Prototype


Parti
Structure
Vertical Movement


Prototype containing infrastructur
Community Centre
Vierendeel Truss structure
Vertical Movement



Ground Floor Plan
1:200 El. 0.0m

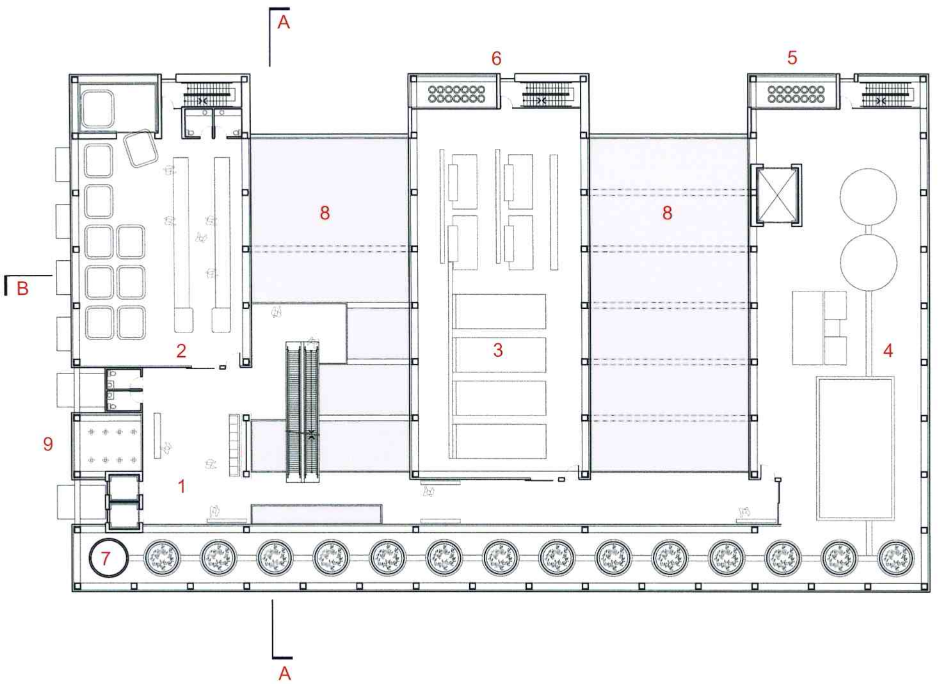


Parking Plan
1:200 El. -3.5m

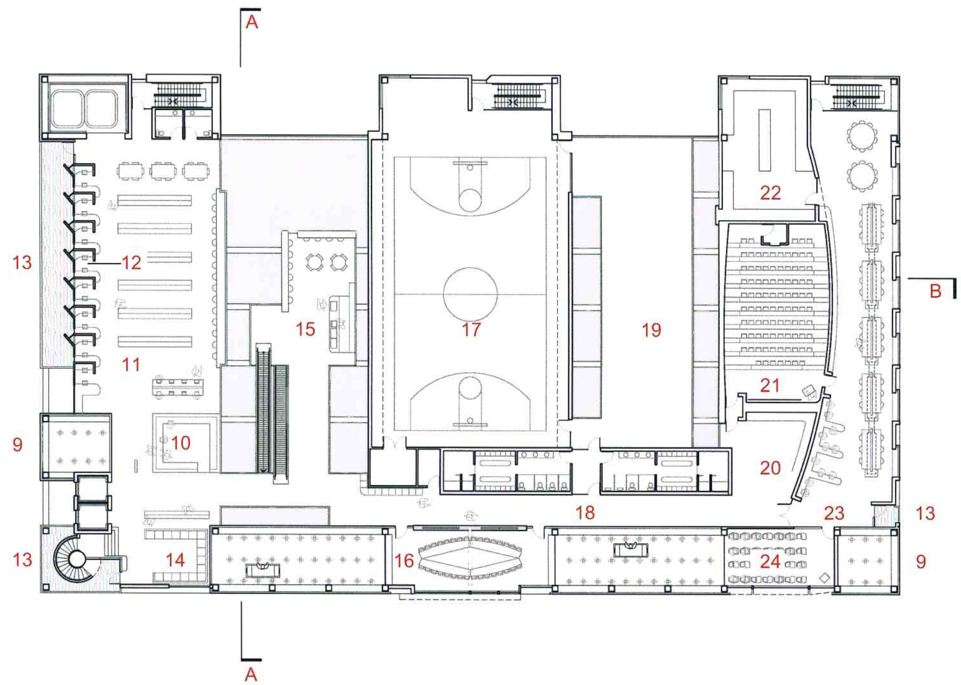
Legend

1. Entry and Lobby
2. Bistro
3. Market
4. Loading and Services
5. Bar and Restaurant
6. Market Entry
7. Pool
8. Vertical Greenhouse
9. Greenhouse Freight Elevator
10. Combined Heat and Power Risers
11. Biofilter and Water Risers
12. Parking Lobby
13. Potable Water Resevoir
14. Hydrogen Storage
15. Underground Service Distribution
16. Water Supply from False Creek
17. Ramp

North



Level Two - ProtoType
1:200 El. 5.0m

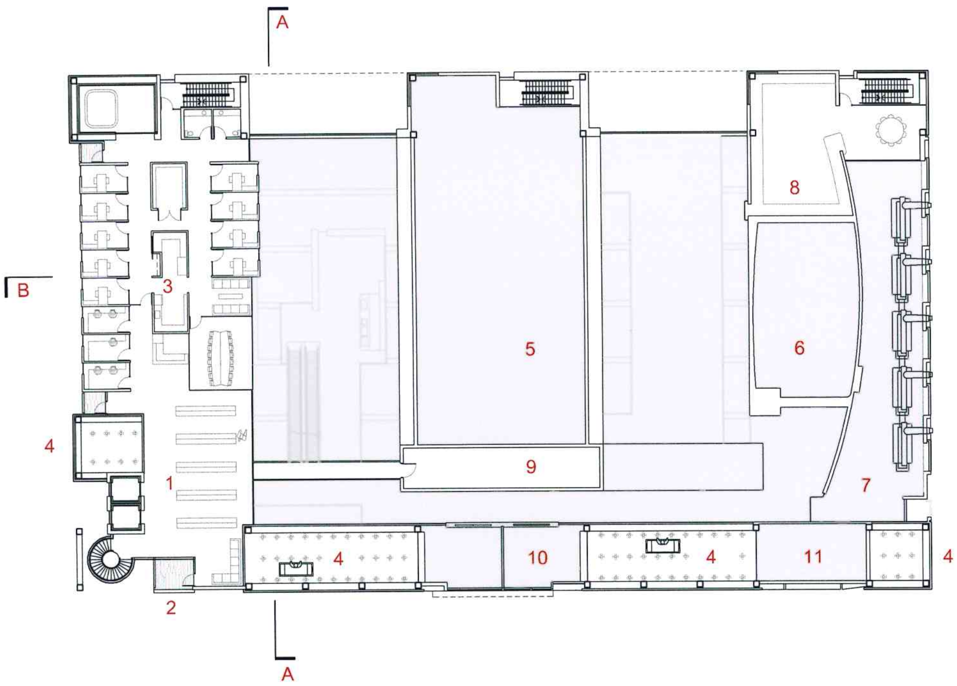


Level Three - Community Centre
1:200 El. 10.0m

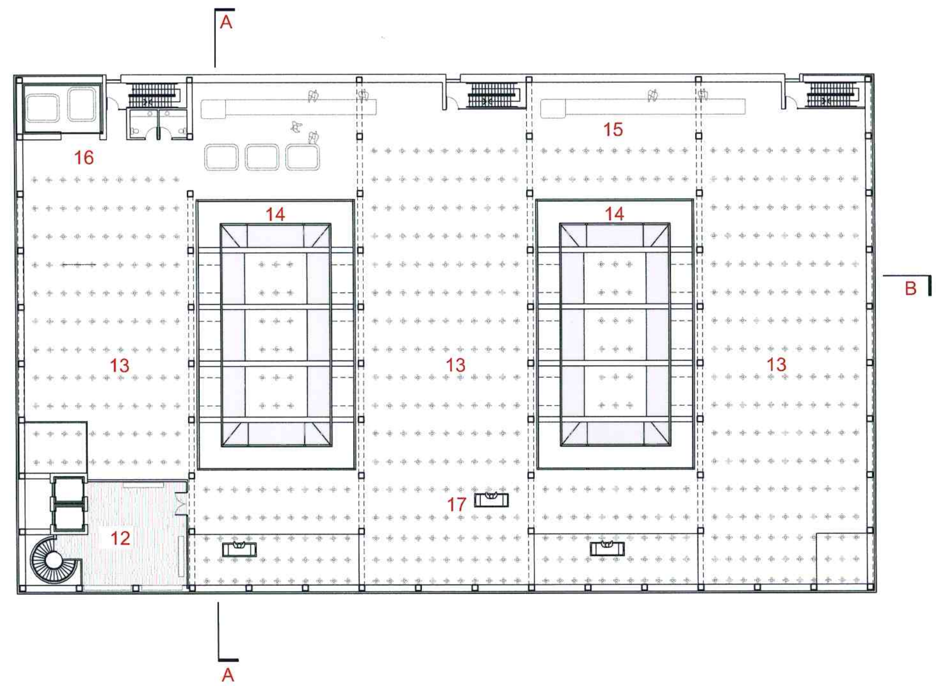
Legend

1. Interpretive Centre
2. Greenhouse food preparation
3. Micro Grid Power and Heat Plant
4. Solar Aquatic Biofilter
5. Biofilter and Water Risers
6. Combined Heat and Power Risers
7. Cleansed Water to Storage Below
8. Open to Below
9. Vertical Greenhouse
10. Library Control Point
11. Library
12. Study Carrels
13. Deck
14. Lounge
15. Juice Bar
16. Flexible Board Meeting Rooms
17. Gym
18. Change Rooms and Washrooms
19. Exercise Area
20. Lecture Hall Lobby
21. Lecture Hall
22. Prototype's Control Centre
23. Lab
24. Classroom

North



Level Four - Library and Staff
1:200 El. 15.0m

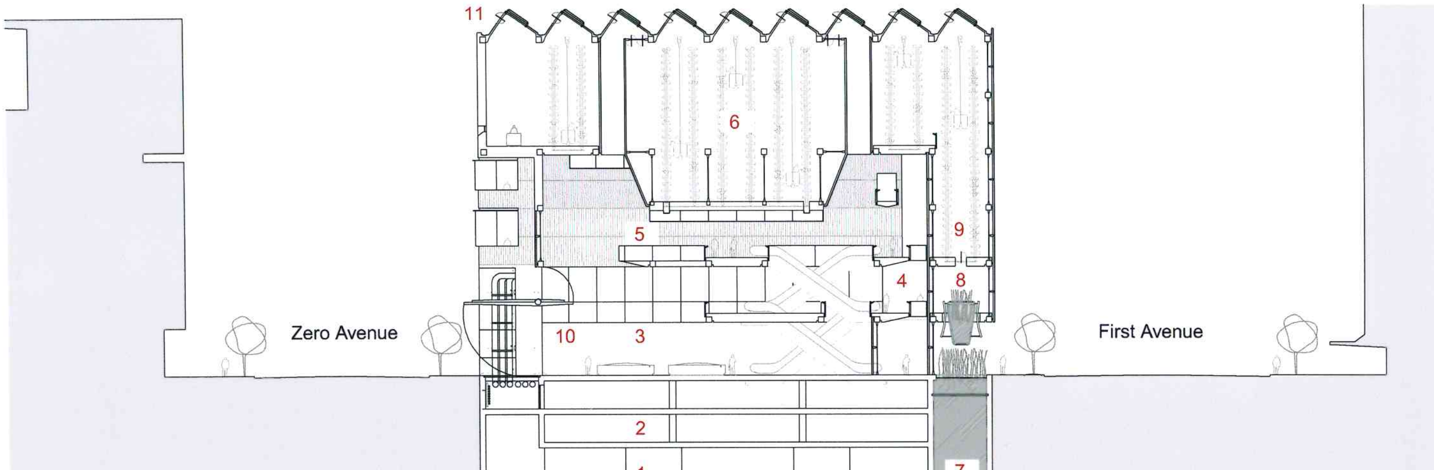


Level Five - Vertical Greenhouse
1:200 El. 20.0m

Legend

1. Upper Library - computer centre
2. Deck
3. Staff Offices and Ancillary Spaces
4. Vertical Greenhouse
5. Open to Gym
6. Open to Lecture Hall
7. Open to Lab
8. Upper Level of Control Centre
9. Library Storage
10. Open to Board / Meeting Rooms
11. Open to Classroom
12. Public Viewing Area
13. Vertical Greenhouse
14. Skylight
15. Greenhouse Work Area
16. Greehouse Freight Elevator
17. Food Harvesting Gantry

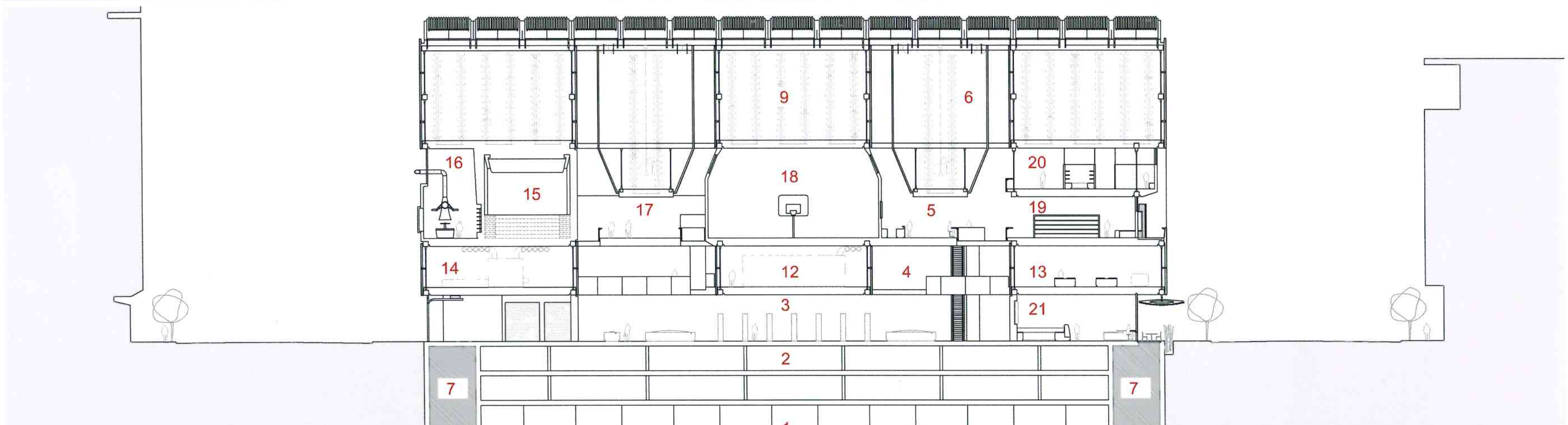
North



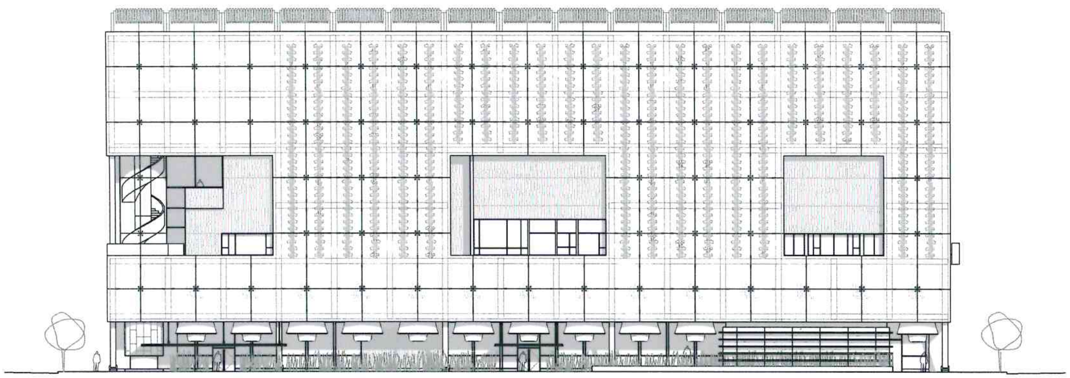
Section A
1:200

Legend

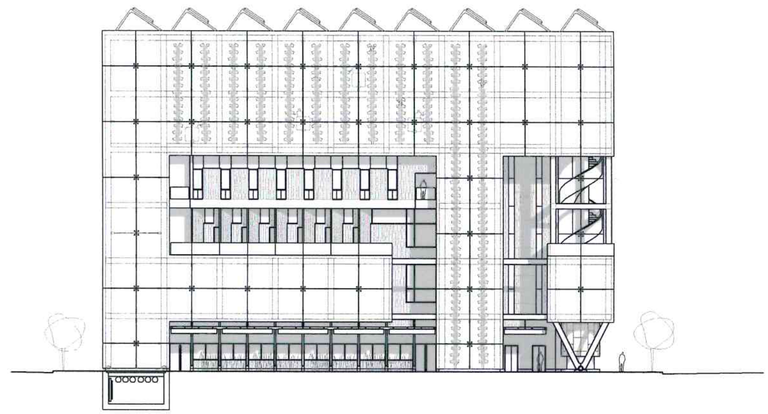
1. Hydrogen Storage
2. Parking
3. Market
4. Interpretive Centre
5. Juice Bar
6. Greenhouse Skylight
7. Potable Water Resevoir
8. Solar Aquatic Tank and Fixture
9. Vertical Greenhouse
10. Market Door Opens to Street
11. Roof light and solar hot water tubes
12. Micro Grid Power and Heat
13. Greenhouse Food Preparation
14. Solar Aquatic Biofilter
15. Lecture Hall
16. Lab
17. Exercise Area
18. Gym
19. Library
20. Upper Library and Staff
21. Bistro



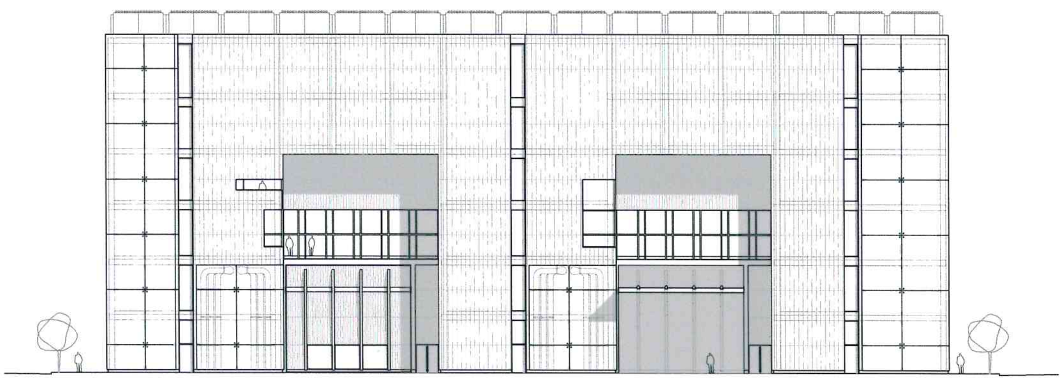
Section B
1:200



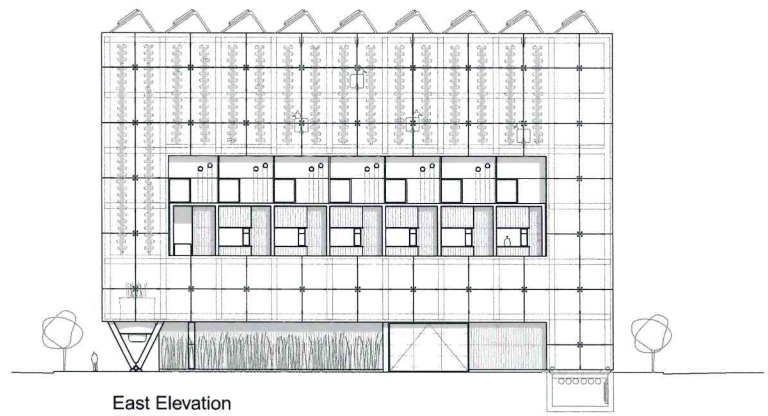
South Elevation
1:200



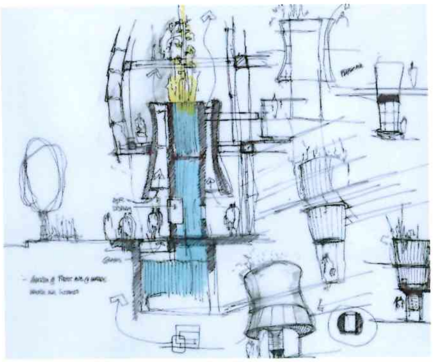
West Elevation
1:200



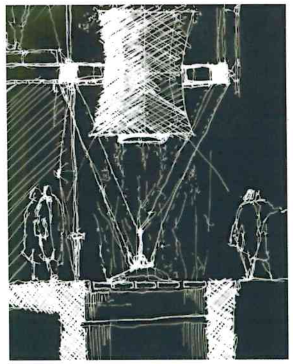
North Elevation
1:200



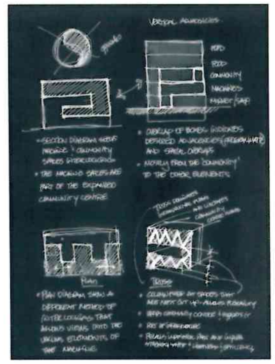
East Elevation
1:200



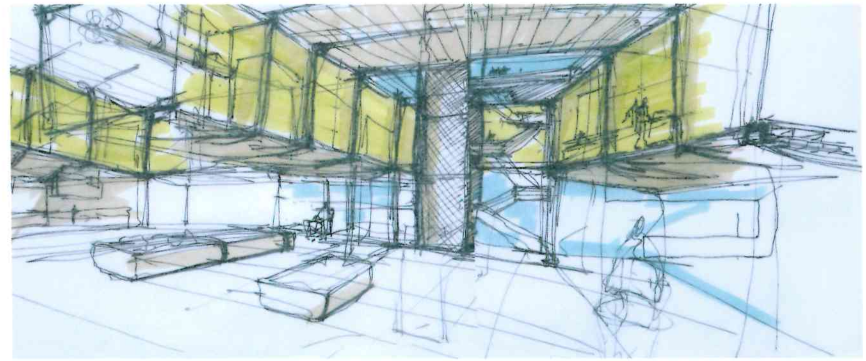
Section Study



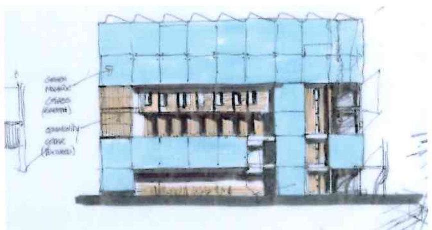
Section Study



Development

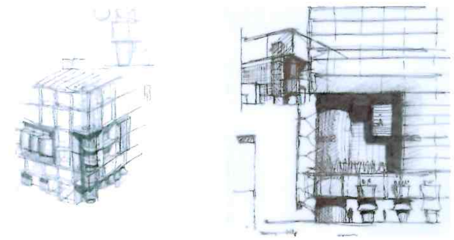


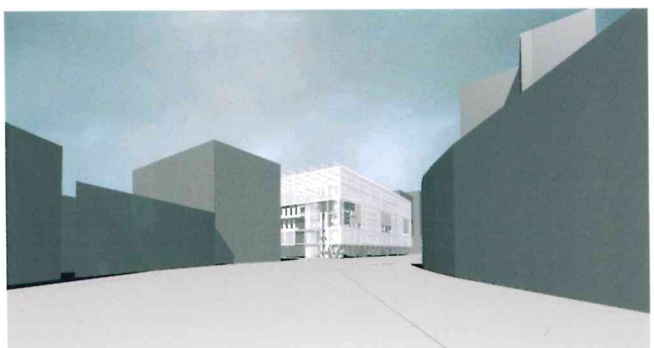
Sketch of Interior of Market



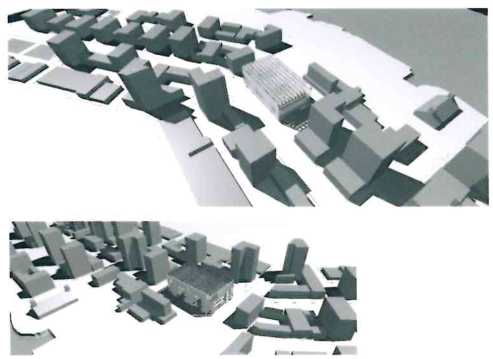
Materials

Corner Studies





View Looking North East - Urban Vista



Aerial Perspectives

View Looking North East